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J6973 U.S. PTO

12-11-00 527 Rec'd PCT/PTC 08 DEC 2000
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09/719323

Docket No. F-6768
Date December 8, 2000

"EXPRESS MAIL" MAILING LABEL NO. EL 666235365US

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Sir:

Transmitted herewith for filing is the ☒ Utility ☐ Design patent application of:

Inventor/Application Identifier: **Toshikazu URA**
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Nationality: **Japan**

For: **RECHARGEABLE BATTERY**

Enclosed are:

☒ 5 sheets of drawings (☒ formal ☐ informal size A4).
☒ 21 pages of specification, including claims and abstract.
☒ 26 total pages

☐ Combined Declaration/Power of Attorney
☐ Newly executed
☐ Copy from prior application
☐ Inventors deleted; see attached statement
☐ Inventor Information Sheet

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☐ Cancel in this application original claims of the prior application before calculating the filing fee.

CLAIMS FILED

For	Number Filed	Number Extra	Rate	Basic Fee	\$860.00
Total Claims	<u>5</u>	<u>0</u> (over 20) x	\$18.00		
Independent Claims	<u>1</u>	<u>0</u> (over 3) x	\$80.00		
<input checked="" type="checkbox"/> Multiple Dependent Claim			\$270.00		<u>270.00</u>
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- ☐ Applicant hereby claims the benefit of the filing date of the following provisional application(s) under the provisions of 35 USC 119.
- ☒ Applicant hereby claims the benefit of the filing date of the following applications under the provisions of 35 USC 119 of which certified copies ☐ will follow ☐ are enclosed ☒ have been filed in the International Bureau ☐ were filed in prior application No. _____.

Japan Patent Appln. No. 11-100750, filed April 8, 1999

- ☐ This is a ☐ Continuation ☐ Divisional ☐ Continuation-in-Part of prior application Serial No. _____.
- ☐ Amend the specification by inserting before the first line the sentence:
--This is a ☐ continuation, ☐ division, ☐ continuation-in-part, of application Serial No. _____, filed _____, --

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F-6768

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Toshikazu URA

Serial No. : Not yet known (U.S. National Stage of PCT/JP00/02304
filed April 7, 2000)

For : RECHARGEABLE BATTERY

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Preliminary to examination, please amend the application as follows:

IN THE CLAIMS

1. (Amended) A rechargeable battery comprising:

an electrode plate group including a positive electrode plate, in which a positive electrode material is attached to a current collector, a negative electrode plate, in which a negative electrode material is attached to a current collector, the positive and negative electrode plates being superimposed with an intervening separator therebetween, wherein the current collector of one or other of the positive electrode plate and the negative electrode plate is projected on at least one side of the electrode plate group for forming by itself a flat plane on one side of the electrode plate group;

an electrolyte;

a battery container in which the electrode plate group and the electrolyte are

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accommodated; and

a current collecting plate joined to the flat plane formed at one side of the electrode plate group.

2. (Amended) The rechargeable battery according to claim 1, wherein the positive electrode plate and the negative electrode plate are wound in spiral fashion with the separator interposed therebetween, with their current collectors being respectively projected at opposite ends of the electrode plate group thereby forming respective projected portions, and flat planes are formed at opposite ends of the electrode plate group by pressing said projected portions of the current collectors at opposite ends of the electrode plate group in directions along the winding axis of the electrode plate group.

3. (Amended) The rechargeable battery according to claim 2, wherein the current collecting plate is arranged in contact with each of the flat planes, and is laser-welded in the radial direction at a plurality of locations in the circumferential direction.

4. (Amended) The rechargeable battery according to claim 2 or 3, wherein the current collecting plate is formed with a plurality of ribs thereon such as to protrude towards the projected portions of the current collectors, the flat planes being formed by pressing said ribs against the projected portions of the current collectors and the current collecting plate is welded to each of the current collectors at said ribs.

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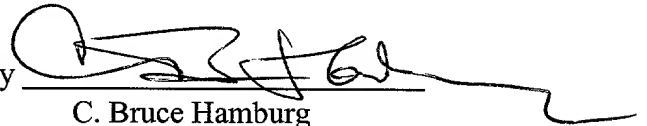
REMARKS

The reference numbers have been deleted from the claims in accordance with preferred U.S. practice and a typographical error has been corrected in claim 2.

Respectfully submitted,

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Enc. - Appendix

APPENDIX I

**AMENDED CLAIMS WITH AMENDMENTS INDICATED THEREIN
BY BRACKETS**

1. (Amended) A rechargeable battery comprising:

an electrode plate group [(10)] including a positive electrode plate [(1)], in which a positive electrode material [(1a)] is attached to a current collector [(1b)], a negative electrode plate [(2)], in which a negative electrode material [(2a)] is attached to a current collector [(2b)], the positive and negative electrode plates being superimposed with an intervening separator [(3)] therebetween, wherein the current collector of one or other of the positive electrode plate and the negative electrode plate is projected on at least one side of the electrode plate group [(10)] for forming by itself a flat plane [(11, 12)] on one side of the electrode plate group;

an electrolyte;

a battery container [(4)] in which the electrode plate group and the electrolyte are accommodated; and

a current collecting plate [(8, 9)] joined to the flat plane [(11, 12)] formed at one side of the electrode plate group.

2. (Amended) The rechargeable battery according to claim 1, wherein the positive electrode plate [(1)] and the negative electrode plate [(2)] are wound in spiral fashion with the separator [(3)] interposed therebetween, with their current collectors [(1b, 2b)] being respectively projected at opposite ends of the electrode plate group [(10)] thereby forming respective

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projected portions, and flat planes [(11, 12)] are formed at opposite ends of the electrode plate group by pressing said projected portions of the current [correctors] collectors at opposite ends of the electrode plate group in directions along the winding axis of the electrode plate group.

3. (Amended) The rechargeable battery according to claim 2, wherein the current collecting plate [(8, 9)] is arranged in contact with each of the flat planes [(11, 12)], and is laser-welded in the radial direction at a plurality of locations in the circumferential direction.

4. (Amended) The rechargeable battery according to claim 2 or 3, wherein the current collecting plate [(8, 9)] is formed with a plurality of ribs [(16)] thereon such as to protrude towards the projected portions of the current collectors [(1b, 2b)], the flat planes [(11, 12)] being formed by pressing said ribs [(16)] against the projected portions of the current collectors [(1b, 2b)], and the current collecting plate [(8, 9)] is welded to each of the current collectors [(1b, 2b)] at said ribs [(16)].

DESCRIPTION

RECHARGEABLE BATTERY

5 TECHNICAL FIELD

The present invention relates to rechargeable batteries, and in particular to rechargeable batteries wherein an electrode plate group obtained by superimposing a positive electrode plate, in which positive electrode material is
10 attached to a current collector, onto a negative electrode plate, in which negative electrode material is attached to a current collector, with a separator therebetween, is accommodated in a battery container together with electrolyte.

15 BACKGROUND ART

In recent years, there has been rapid progress in reducing the size and weight of electronic equipment, which has increased demands to reduce the size and weight and increase the capacity of the batteries used as their power
20 sources.

To meet these demands, lithium ion rechargeable batteries employing a carbon-based material as the negative electrode active material and a transition metal oxide containing lithium, such as LiCoO_2 , as the positive electrode
25 active material have been put into practice by various

companies. Lithium rechargeable batteries in which metallic lithium or lithium alloy is employed as the negative electrode active material had the problem that the lithium precipitated on the negative electrode as charging proceeded.

5 On the other hand, lithium ion rechargeable batteries are free of such problem and so have excellent cycle characteristics. As a result, there has been vigorous development of lithium ion rechargeable batteries and their use in electronic equipment has become more common.

10 Lithium rechargeable batteries are studied also as a means for solving global environmental problems or energy problems. As a way of guaranteeing power stability while maintaining a good global environment, implementation of technology for load equalization is desired; considerable
15 benefits in terms of load equalization could be expected if use of small-scale battery power storage devices capable of storing power during the night could be made common in ordinary households etc. In order to prevent atmospheric pollution by car exhaust gases and global warming due to CO_2 ,
20 it would also be desirable to extend the use of electric vehicles in which some or all of the motive power is obtained by rechargeable batteries. Large lithium ion rechargeable batteries with a cell capacity of about 100 Ah are therefore being developed for use as battery power storage devices for
25 domestic use and as power sources for electric vehicles.

The construction of such a lithium ion rechargeable battery is shown in Figure 5. An electrode plate group 30 constituted by superimposing a positive electrode plate 21, in which positive electrode material 21a is attached to a positive electrode current collector 21b, and a negative electrode plate 22, in which negative electrode material 22a is attached to a negative electrode current collector 22b, wound in spiral fashion with a separator 23 therebetween are accommodated in a battery container 24 comprising a battery case 25 and a battery closure 26 together with electrolyte. A positive electrode current collector tab 28 with one end joined to a suitable location of the positive electrode current collector 21b has its other end connected to the inner surface of the battery closure 26 constituting the positive electrode terminal, while a negative electrode current collector tab 29 with one end joined to a suitable location of the negative electrode current collector 22b has its other end connected to the inside bottom surface of the battery case 25 constituting the negative electrode terminal. An insulating packing 27 is interposed between the inner circumference of the top end aperture of the battery case 25 and the outer circumference of the battery closure 26 so as to mutually insulate the battery case 25 and the battery closure 26 and to seal the battery container 24.

However, since current was extracted from a single location of a positive electrode plate 21 and a negative electrode plate 22 through current collecting tabs 28 and 29 in this structure, the average distance from the positive electrode plate 21 and negative electrode plate 22 to the current collecting tabs 28 and 29 was long. Moreover, the area of current collecting tabs 28 and 29 was small, so their electrical resistance was large and the current collecting efficiency was poor. Furthermore, since the current collecting efficiency was poor, there was the problem that charging and discharging with large currents resulted in increased battery temperatures, which shortens the life of the rechargeable battery.

Laid-open Japanese Patent Application No. 8-115744, for example, discloses an electrode plate group which is directed to solve these problems. In this electrode plate group, current collectors are respectively projected at one side of the electrode plates, with respective leads being attached to the leading ends of these projected portions of the current collectors. Therefore when the electrode plates are wound in spiral fashion, the leads and the end edges of the current collectors respectively form a positive electrode end face and a negative electrode end face at opposite ends of the electrode plate group. Both terminals are connected to the positive electrode end face and the negative electrode end

face respectively. However, such structure is subject to the problem of high cost, since leads are required and the manufacturing steps are complicated.

Laid-open Japanese Patent Application No. 10-21953

5 discloses an arrangement in which current collectors of both electrode plates project respectively on opposite sides and their tips make resilient pressure contact with the positive electrode terminal and negative electrode terminal. However, the connection between the current collectors and the
10 terminals is only effected by the elastic restoring force of the tips of the current collectors, which are bent at an acute angle within a certain range of elasticity. Therefore, the electrical connection is unstable, and the output of the battery also lacks stability under conditions of use in which
15 it is subjected to vibration.

In view of the above problems of the prior art, an object of the present invention is to provide a rechargeable battery wherein the efficiency of current collection is high, the rise in temperature during charging/discharging can be
20 reduced, and in which charging/discharging can be achieved in a stable fashion with an inexpensive construction.

DISCLOSURE OF THE INVENTION

A rechargeable battery according to the present invention comprises: an electrode plate group including a positive electrode plate, in which a positive electrode material is attached to a current collector, a negative electrode plate, in which a negative electrode material is attached to a current collector, the positive and negative electrode plates being superimposed with an intervening separator therebetween, wherein the current collector of one or other of the positive electrode plate and the negative electrode plate is projected on at least one side of the electrode plate group for forming by itself a flat plane on one side of the electrode plate group; an electrolyte; a battery container in which the electrode plate group and the electrolyte are accommodated; and a current collecting plate joined to the flat plane formed at one side of the electrode plate group. Since the current collecting plate is joined to the flat plane formed by a side portion of the current collectors, the current collection efficiency is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat plane is formed by the current collector itself, the construction can be made inexpensive. Moreover, the construction is stable with respect to vibration etc since the current collecting plate is welded to the flat plane of the current collector, so charging and discharging can be effected in a stable fashion.

If the positive electrode plate and the negative electrode plate are wound in spiral fashion with the separator interposed therebetween, with their current collectors being respectively projected at opposite ends of the electrode plate group thereby forming respective projected portions, flat planes can be formed at opposite ends of the electrode plate group efficiently by pressing the projected portions of the current correctors at opposite ends of the electrode plate group in directions along the winding axis of the electrode plate group.

The current collecting plate may be arranged in contact with each of the flat planes and laser-welded in the radial direction at a plurality of locations in the circumferential direction, so that a large number of locations of the side edges of the current collectors can be integrally welded in a simple fashion to the current collecting plates, making it possible to achieve high current collection efficiency with an easy operation.

Alternatively, a plurality of ribs may be formed on the current collecting plate such as to protrude towards the projected portions of the current collectors, the flat planes being formed by pressing the ribs against the projected portions of the current collectors, and the current collecting plate being welded to each of the current collectors at these ribs, so that the current collector

plates make reliable contact with the current collectors at these ribs and they can be welded together even more reliably.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1 is an axial cross-sectional view of a rechargeable battery according to one embodiment of the present invention;

10 Figure 2 is an axial cross-sectional view of an electrode plate group in this embodiment in a step wherein a flat plane is formed by the projected portion of a current collector;

15 Figure 3 is a perspective view of the electrode plate group in this embodiment in a step in which the current collecting plate is joined to the flat plane of the current collector;

 Figure 4 is a perspective view of a modified example of current collecting plate in a state welded to the electrode plate group in the rechargeable battery according to the present invention; and

20 Figure 5 is an axial cross-sectional view of a rechargeable battery according to an example of the prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

25 A lithium ion rechargeable battery according to an embodiment of the rechargeable battery of the present

invention is described below with reference to Figure 1 to Figure 3.

In Figure 1, reference numeral 1 represents a positive electrode plate and reference numeral 2 represents a negative electrode plate. An electrode plate group 10 is constituted by winding in spiral fashion the positive electrode plate 1 and the negative electrode plate 2 in a mutually opposed condition with a separator 3 made of microporous polyethylene film therebetween. This electrode plate group 10 is accommodated within a battery container 4 together with electrolyte. The battery container 4 comprises a battery case 5 which is of cylindrical enclosure shape and constitutes a negative electrode terminal, and a battery closure 6 constituting a positive electrode terminal. An insulating packing 7 is interposed between the inner circumference of the top aperture of the battery case 5 and the outer circumference of the battery closure 6, whereby mutual insulation is effected therebetween and the battery container 4 is sealed. The separator 3 is interposed also between the electrode plate group 10 and the inner circumference of the battery case 5.

The positive electrode plate 1 is constituted by coating both surfaces of a positive electrode current collector 1b with a positive electrode material 1a; a side part (in the example illustrated, the top part) of this positive electrode

current collector 1b projects from the portion that is coated with the positive electrode material 1a. The negative electrode plate 2 is constituted by coating both surfaces of a negative electrode current collector 2b with a negative electrode material 2a; a side part opposite from the projected portion of the positive electrode current collector 1b (in the example illustrated, the bottom part) of this negative electrode current collector 2b projects from the portion that is coated with the negative electrode material 2a. The separator 3 projects to the outside beyond both side edges of the coated portions of the positive electrode plate 1 and the negative electrode plate 2.

The side edge of the positive electrode current collector 1b that projects further than the separator 3 is elastically deformed by applying pressure thereto, whereby a flat plane 11 is formed. A positive electrode current collecting plate 8 is joined to this flat plane 11. Likewise, the side edge of the negative electrode current collector 2b that projects further than the separator 3 is elastically deformed by applying pressure thereto, whereby a flat plane 12 is formed, and a negative electrode current collecting plate 9 is joined to this flat plane 12. The positive electrode current collecting plate 8 and the negative electrode current collecting plate 9 are respectively connected to the battery closure 6 and the battery case 5.

Reference numerals 8a and 9a respectively denote connecting strips extending from the outer circumference of the current collecting plates 8 and 9 for connecting them to the inside surface of the battery closure 6 and the inside bottom surface of the battery case 5, respectively.

A detailed description of the positive electrode plate 1, the negative electrode plate 2, and the electrolyte will now be given. The positive electrode current collector 1b is made of aluminum foil or the like. The positive electrode plate 1 is constituted by coating both surfaces of the positive electrode current collector 1b with a positive electrode material 1a containing a positive electrode active material and a binder. For the positive electrode active material, LiCoO_2 , LiMn_2O_4 , LiNiO_2 , any other lithium oxide in which one of Co, Mn or Ni is substituted with another transition metal, or a lithium-containing transition metal oxide other than these may be used. In particular, Mn-based lithium-containing transition metal oxides such as the globally abundant low-cost LiMn_2O_4 are suitable.

The negative electrode current collector 2b is made of copper foil or the like, and the negative electrode plate 2 is constituted by coating both surfaces of the negative electrode current collector 2b with a negative electrode material 2a containing a negative electrode active material and a binder. For the negative electrode active material,

carbon-based materials such as graphite, petroleum coke, carbon fiber, or organic polymer sintered products, or metals or oxides, or composite materials of these capable of occluding and releasing lithium, may be used.

5 The electrolyte may be obtained by dissolving a lithium salt such as lithium hexafluorophosphate (LiPF_6), lithium perchlorate (LiClO_4), or lithium fluoroborate (LiBF_4) into a non-aqueous solvent such as ethylene carbonate (EC), propylene carbonate (PC), diethylene carbonate (DEC) or
10 ethylene methyl carbonate (EMC), either alone or in combination, at a concentration of 0.5 mol/dm^3 to 2 mol/dm^3 .

To give a specific example, electrolyzed manganese dioxide (EMD: MnO_2) and lithium carbonate (Li_2CO_3) were mixed at a ratio $\text{Li/Mn} = 1/2$ and sintered in the atmosphere of 800°C
15 for 20 hours, whereby LiMn_2O_4 was produced as the positive electrode active material. The positive electrode material 1a was then obtained by mixing, by weight, 92% LiMn_2O_4 , 3% acetylene black serving as conducting agent, and 5% polyfluorovinylidene as binder. In order to knead the
20 positive electrode material 1a into the form of a paste, the polyfluorovinylidene serving as the binder was employed in the form of N-methylpyrrolidone dispersion. The mixing ratios given above are ratios in terms of the solid fractions. Both faces of the positive electrode current collector 1b
25 made of $20 \text{ }\mu\text{m}$ thick aluminum foil were coated with this

positive electrode material paste such that positive electrode material layers were formed except a region of width 10 mm on one side edge, which was left uncoated. The film thickness of both positive electrode material layers was the same and the sum of the two film thicknesses after coating and drying was 280 μm , giving a positive electrode plate thickness of 300 μm . After this, the positive electrode plate 1 was compressed using a press roll of diameter 300 mm, to reduce the thickness of the positive electrode plate 1 to 200 μm . The density of the positive electrode material was then 3.0 g/cm^3 .

For the negative electrode material 2a, a mixture of artificial graphite and styrene butadiene rubber (SBR) as a binder in a weight ratio of 97:3 was employed. In order to knead the negative electrode material 2a into the form of a paste, the styrene butadiene rubber binder was employed in the form of an aqueous dispersion. The above mixing ratios are expressed as solid fractions. Both faces of the negative electrode current collector 2b made of 14 μm thick copper foil were coated with this negative electrode material paste such that negative electrode material layers were formed except a region of width 10 mm on one side edge, which was left uncoated. After this, the negative electrode plate 2 was compressed using a press roll of diameter 300 mm, to reduce the thickness of the negative electrode plate 2 to 170 μm .

The density of the negative electrode material was then 1.4 g/cm³.

The electrolyte was obtained by dissolving lithium hexafluorophosphate (LiPF₆) as solute in a concentration of 1 mol/dm³ in a solvent obtained by mixing ethylene carbonate (EC) and diethylene carbonate (DEC) in a volume blending ratio of 1:1.

These positive electrode plate 1 and negative electrode plate 2 thus produced are opposed to each other with an intervening separator 3 therebetween and wound around in spiral fashion to form an electrode plate group 10, in such a manner that the portions of the current collectors 1b, 2b which were left uncoated project at opposite ends of the electrode plate group 10. This electrode plate group 10 is inserted and arranged in position in a molding jig 13 of cylindrical enclosure shape as shown in Figure 2, and is subjected to pressure by a pressing member 14 from one end aperture of the molding jig 13. Thereby, the projected portions of the current collectors 1b, 2b are elastically deformed to be bent radially inwards substantially at 90° as shown by the phantom lines, whereby flat planes 11, 12 are formed at opposite ends of the electrode plate group. Since the positive electrode plate 1 and the negative electrode plate 2 are wound in spiral fashion, the projected portions of the current collectors 1b, 2b are not bent radially

outwards. Rather, all of the projected portions of the current collectors are uniformly and progressively bent radially inwards. As a result, although folding may occur to some extent, they are as a whole deformed together into flat
5 planes 11, 12.

Next, the electrode plate group 10 formed with flat planes 11, 12 is removed from the molding jig 13 and, as shown in Figure 3, the current collecting plates 8, 9 are pressed into contact with the flat planes 11, 12, and these
10 are laser welded together by irradiating a plurality of locations in the circumferential direction of the surfaces of the current collecting plates 8, 9 with a laser beam 15 in radial fashion from the middle towards the outer periphery. After this, the electrode plate group 10 with these current
15 collecting plates 8, 9 joined thereto is accommodated within the battery case 5 and vacuum-impregnated with the electrolyte. The current collecting plates 8, 9 are connected by laser welding etc to the battery closure 6 and the battery case 5, respectively, and the battery case 5 is
20 sealed with the battery closure 6.

As described above, the electrode plate group 10 in this lithium ion rechargeable battery is constituted by winding in spiral fashion a positive electrode plate 1 and a negative electrode plate 2 with a separator 3 therebetween, such that
25 the current collectors 1b, 2b of the two electrode plates

respectively project at opposite ends thereof and the current collecting plates 8, 9 are joined to the flat planes 11, 12 formed by the projected portions of the current collectors 1b, 2b. Accordingly, the efficiency of current collection is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat planes 11, 12 are formed by the current collectors 1b, 2b themselves, the construction can be made of low cost. Furthermore, the construction is stable with respect to vibration etc, because these flat planes 11, 12 are welded to the current collecting plates 8, 9, so charging and discharging can be effected in a stable fashion.

Since the flat planes 11, 12 for joining the current collecting plates 8, 9 are formed by applying pressure to both ends of the electrode plate group 10 in the direction along the core of the winding axis, they can be formed efficiently.

The current collecting plates 8, 9 are pressed towards the flat planes 11, 12 and subjected to laser welding in the radial direction at a plurality of locations in the circumferential direction in this tightly pressed condition. Therefore, integral welding of a large number of locations of the side edges of the current collectors 1b, 2b to the current collecting plates 8, 9 can be achieved in a

straightforward fashion, enabling high current collection efficiency to be achieved with ease of operation.

In the description of the above embodiment, an example was given in which the entire surface of the current

5 collecting plates 8, 9 was of flat plate shape. Figure 4 illustrates a modified example of a current collecting plate 8 or 9, in which a plurality of ribs 16 are formed projecting towards the projected portions of the current collectors 1b, 2b of the electrode plate group 10 in radial fashion. Laser
10 welding is effected along these ribs 16 under a condition in which the current collecting plates 8, 9 are pressed toward the electrode plate group 10 such that these ribs 16 bite into the projected portions of the current collectors 1b, 2b so as to form the flat planes 11, 12.

15 If such ribs 16 are provided on the current collecting plates 8, 9 and laser welding is conducted with these being pressed against the projected portions of the current collectors 1b, 2b, the flat planes 11, 12 formed by the projected portions make reliable contact with the current
20 collecting plates 8, 9 through the ribs 16, whereby the current collecting plates 8, 9 and the current collectors 1b, 2b can be welded together even more reliably.

INDUSTRIAL APPLICABILITY

As will be clear from the above description, with the rechargeable battery of the present invention, the current collector of one or other of the electrodes projects on at least one side of the electrode plate group, a flat plane
5 being formed at the tip of this projected portion by itself, and a current collector plate is welded to this projected portion of the current collector. Accordingly, the current collection efficiency is high and the rise in temperature during charging/discharging can be made small. Since the
10 flat plane is formed by the current collector itself, an inexpensive construction can be achieved, and since the current collecting plate is joined to the flat plane, the construction is stable with regard to vibration etc. The present invention thereby realizes an inexpensive structure
15 for electrode plate group with which the battery exhibits excellent current collection efficiency and stable charging/discharging characteristics.

CLAIMS

1. A rechargeable battery comprising:

an electrode plate group (10) including a positive
5 electrode plate (1), in which a positive electrode material
(1a) is attached to a current collector (1b), a negative
electrode plate (2), in which a negative electrode material
(2a) is attached to a current collector (2b), the positive
and negative electrode plates being superimposed with an
10 intervening separator (3) therebetween, wherein the current
collector of one or other of the positive electrode plate and
the negative electrode plate is projected on at least one
side of the electrode plate group (10) for forming by itself
a flat plane (11, 12) on one side of the electrode plate
15 group;

an electrolyte;

a battery container (4) in which the electrode plate
group and the electrolyte are accommodated; and

a current collecting plate (8, 9) joined to the flat
20 plane (11, 12) formed at one side of the electrode plate
group.

2. The rechargeable battery according to claim 1,
wherein the positive electrode plate (1) and the negative
25 electrode plate (2) are wound in spiral fashion with the

separator (3) interposed therebetween, with their current collectors (1b, 2b) being respectively projected at opposite ends of the electrode plate group (10) thereby forming respective projected portions, and flat planes (11, 12) are
5 formed at opposite ends of the electrode plate group by pressing said projected portions of the current correctors at opposite ends of the electrode plate group in directions along the winding axis of the electrode plate group.

10 3. The rechargeable battery according to claim 2, wherein the current collecting plate (8, 9) is arranged in contact with each of the flat planes (11, 12), and is laser-welded in the radial direction at a plurality of locations in the circumferential direction.

15

4. The rechargeable battery according to claim 2 or 3, wherein the current collecting plate (8, 9) is formed with a plurality of ribs (16) thereon such as to protrude towards the projected portions of the current collectors (1b, 2b),
20 the flat planes (11, 12) being formed by pressing said ribs (16) against the projected portions of the current collectors (1b, 2b), and the current collecting plate (8, 9) is welded to each of the current collectors (1b, 2b) at said ribs (16).

ABSTRACT

In a rechargeable battery in which an electrode plate group (10) obtained by superimposing a positive electrode plate (1), in which positive electrode material (1a) is attached to a positive electrode current collector (1b), and a negative electrode plate (2), in which negative electrode material (2a) is attached to a negative electrode current collector (2b), with a separator (3) therebetween is accommodated in a battery container (4) together with electrolyte, the current collectors (1b, 2b) of the electrode plates (1, 2) are respectively projected at opposite ends of the electrode plate group (10), forming by themselves flat planes (11, 12) by being pressed, and current collecting plates (8, 9) are joined to these flat planes (11, 12).

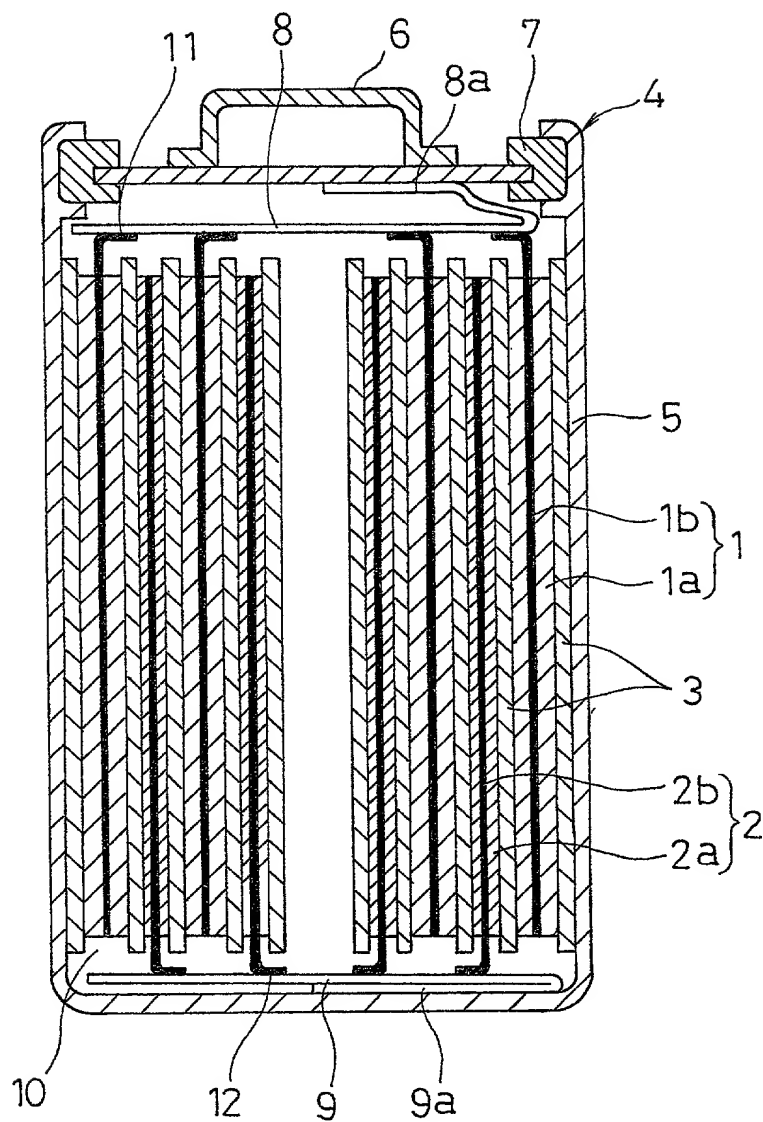
Fig. 1

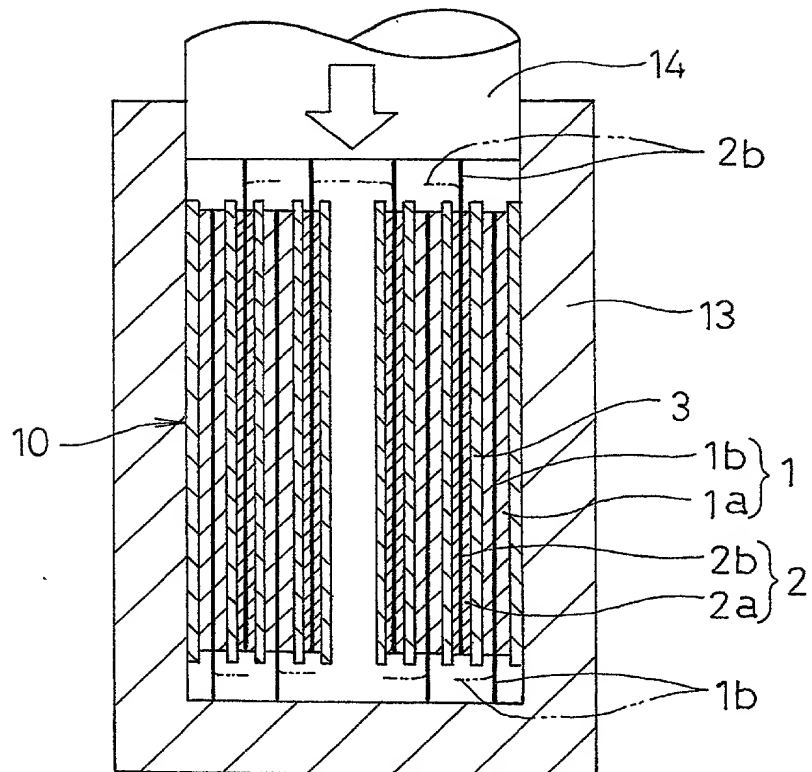
Fig. 2

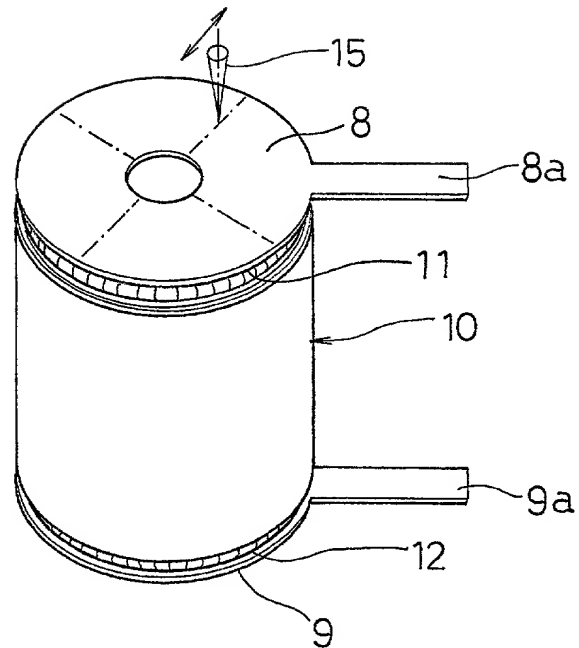
Fig. 3

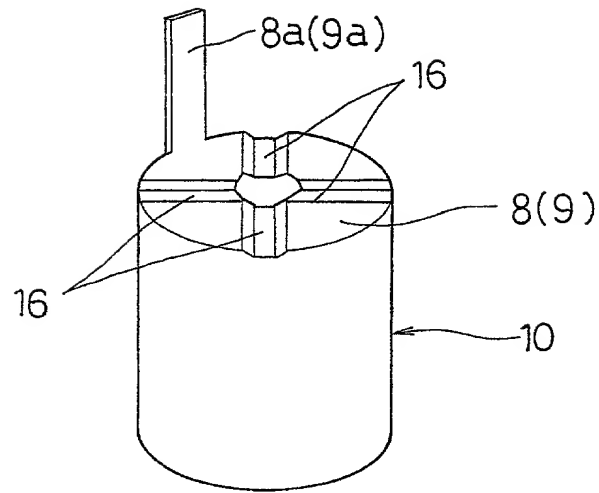
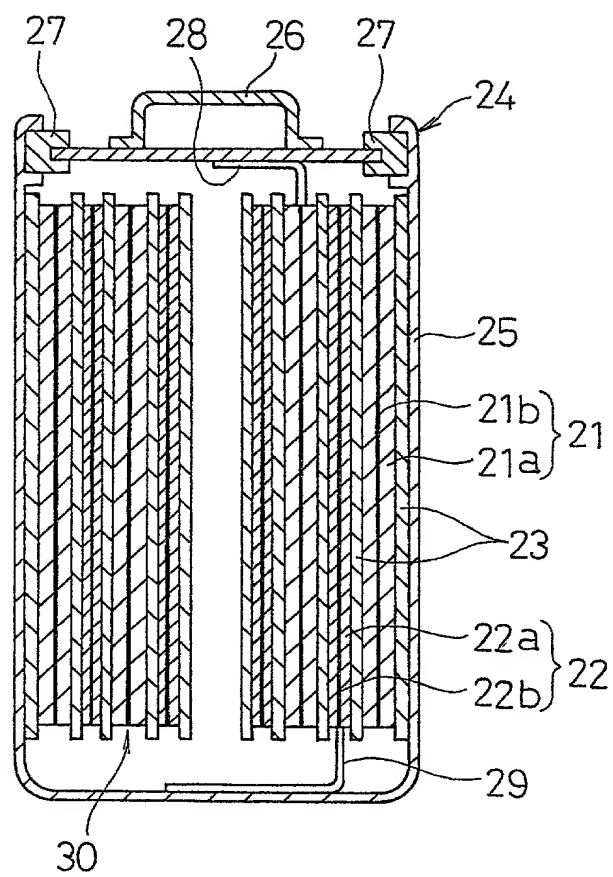
Fig. 4

Fig. 5
Prior Art



COMBINED DECLARATION FOR PATENT APPLICATION AND
POWER OF ATTORNEY

(Includes Reference to PCT International Applications)

Attorney's Docket Number

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"Rechargeable Battery"

the specification of which (check only one item below):

- ☐ is attached hereto.
- ☐ was filed as United States application
Serial No. _____
on _____,
and was amended
on _____ (if applicable).
- ☒ was filed as PCT international application
Number PCT/JP00/02304
on April 7, 2000
and was amended under PCT Article 19
on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:			
Country (if PCT indicate "PCT")	Application Number	Date of Filing (day, month, year)	Priority Claimed Under 35 USC 119
Japan	11-100750	08/04/1999	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

**COMBINED DECLARATION FOR PATENT APPLICATION AND
POWER OF ATTORNEY (Continued)**
(Includes Reference to PCT International Applications)

Attorney's Docket Number

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:				
U.S. APPLICATIONS			STATUS (Check One)	
U.S. Application Number	U. S. Filing Date		Patented	Pending
PCT APPLICATIONS DESIGNATING THE U.S.				
PCT Application No.	PCT Filing Date	U.S. Serial Numbers Assigned (if any)		

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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